BASIC INGREDIENTS SELECTOR

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Abstract—The project deals with a machine that simplifies the effort of chefs. It is basically an ingredient selector that is calibrated to provide correct amounts of powdered ingredients. The manual selection procedure done as of now can be avoided.

This project was initially based on the principle of the screw conveyor mechanism employed in coffee makers. This was then modified to a better design wherein the volume of powder falling could be predetermined. The design consisted of various slotted discs which were subsequently arranged so that the required amount of powdered substance could fall. The basic components included in this would be: input panel, a screw extruder, motors (in order to rotate the system), reservoirs (to hold different powders), and microcontrollers (programmed to analyze the input and hence control rotation).

The working of this apparatus is essentially guided by a control circuit. The dimensions of the discs and the slots were determined based on basic dimensions by finding out the corresponding volume for a unit tablespoon of powders. This rotation is provided from a motor and if necessary appropriate gear reduction systems are adopted. The system can be designed to hold as many types of powders as required within appropriate reservoirs. Each of the ingredients can be selected by a selector switch.

The input panel consists of an LED display along with switches. Other function keys may also be included. Further modifications to this apparatus may be provided such as mixing of ingredients and also saving quantity of suitable ingredients for a particular recipe can be done.

Keyword:- selector disc, slotted disc, analysis

1.INTRODUCTION

1.1CHOICE OF PROJECT

A utility product was deemed to be an ideal choice for a final year project. On this note, several ideas crept up and it ended with going for a device from here on called 'The Ingredient Selector'. This device was first thought of keeping in mind the difficulties involved in manually selecting the correct amount of an ingredient for a particular recipe. This idea was followed by discussions that helped determine the method in which such a device could be fabricated. A brief survey was conducted to get views on how the product would be beneficial. A thorough research rendered that this device would be of great use in restaurants.

A major problem faced with restaurant owners is the inefficiency to get the exact quantity of ingredients being used daily. With a machine that would provide exact amounts of ingredients, this makes the job of restaurant workers easier.

The realization dawned that the makings of this device would need a good deal of programming as well as the use of micro controllers. The first priority however was to determine whether machines of this kind exists wherein powdered substances are precisely selected and provided. The coffee machine was one such product that gives an exact amount of coffee powder according to the size of cup. The device is so calibrated to give this amount according to the input, i.e. if the cup chosen on the machine is a small cup, the amount of coffee powder as well as milk would be of small amounts; thus the amount is present. Therefore the initial idea was to adopt the mechanism of the coffee machine into the system and a search was made for the same. This was then modified to bring in our own design for the selection of powder. The project here deals with a working model of a product that could be beneficial in the industry as well as in households.

1.2 PROJECT OBJECTIVES

The major objectives of the project were as follows:

1. To fabricate and calibrate a device that selects and provides the exact amount of powdered ingredients.
2. To simplify the manual selection of ingredients.
3. Modifying the mechanism involved in a coffee machine was the method to be adopted.

Main parts:
1. Input system
2. Mechanism for selecting the correct amount of powder
3. Reservoir of powder
4. Output

The input system was to consist of an electronic system wherein the input values of the device were to be entered by the user. According to the value entered by the user, the correct amount of powder required was to be selected. This was to be done using appropriate mechanisms for selection of the amount of powder. The powdered ingredients were to be held in a reservoir preferably a hopper like substance that would easily transmit the powder down to the selector

mechanism. The output system consisted of trays wherein the powder could be collected and even load sensors could be provided so as to check whether the right amount has fallen.

2.THEORETICAL STUDY

2.1 RESEARCH INVOLVED

A little research and survey was conducted, so as to determine how useful the product would turn out to be. Initial survey revealed that such a machine for selecting the precise amounts of powder was not present. The survey revealed that the use of such a device could be of good use in households. Most people have trouble selecting the correct amounts of ingredients for various foods. Often the confusion arises as to how much of powder is needed when the amount of food to be prepared is of greater quantity. Precise measurement is not possible and people still use measurement by teaspoons and tablespoons etc. Hence the usability of this machine in houses was understood.

Another area where this product could find its reliability was in hotels/restaurants. A major concern of restaurant owners is the difficulty in keeping a measure of ingredients that have been used up. Cooks tend to have no particular measure of the substances utilized. The realization dawned that the product would make great use here as well. Only the inputted volume of powder would be made available and an exact measure could be provided. Hence with 2 areas of having the product come to use, a plan was set out for the design of the product.

The coffee machine was one kind of machine that required selection of exact amounts of powder for a cup of coffee. Research revealed that the coffee machines employed the principle of screw extruders. Thus, the kind of screw model used in these kinds of machines and also the capacity involved with the motor for running the same was found out. A major coffee machine product manufacturer was contacted, and the details of this product were collected. A screw conveyor was obtained from the agency so as to check whether a model based on the screw conveyor was suited to the application.

2.2 THE PROBLEM

2.2.1 Problem Definition

Each recipe requires an exact quantity of ingredients in order to have a desired taste. According to the quantity of food being prepared, the amount of ingredients required varies. In households, manual selections of powders are made according to the quantity of food by measuring using table spoons or measuring cups. In restaurants too, as food is being prepared the owners need to know the exact amount of curry powder being used every time and the chefs are required to provide this value. Therefore, currently the manual selection of powder involved the need for experts and this posed a major problem. The complications of fabricating such a machine was mainly due to the sensing of powdered substances, as opposed to fluid flow, solid substances require highly sensitive equipment to sense their flow. This would incur major expenses and it was required to select an appropriate mechanism for the same.

2.2.2 Solution

In response to these problems, a decision was made to design a machine that helps in providing exact amounts of powdered substance using suitable mechanisms. The machine is supposed to provide powder as per requirement of the end user. The device is to consist of compartments or reservoirs to be filled with 3 types of powder according to the user's choice. The user is to select the amount of powder required and this is to be the input to the machine. The various designs that would be suitable for providing such a precise delivery of powder were to be worked upon. The project would involve programming and use of microcontrollers. The required amount and type of powder falls onto a tray that can be detached from the device and put to subsequent use.

3.PLANNING AND PROTOTYPING

3.1 INITIAL MODEL

The initial model was based on the principles of the mechanism used in a coffee machine. A screw conveyor was borrowed from a manufacturer and a design was made to suit it.

Fig. 3.1 Initially Proposed Model

The model shown in Fig. 3.1 was the basis for the initial design. A prototype of this initial design was made using form sheet and the screw conveyor. It was tested by adding some powdered ingredients. It was seen that the powder fell in an uneven manner. This revealed that the mechanism adopted in the coffee machine would not suit the selection of ingredients. Since the requirement was for a precise amount, the mechanism for delivering the powder should not have any hindrances to the flow. The design was modified to have one that could have the reservoir of powder having the screw conveyor within it. This design seemed apt and a prototype was designed using form sheet. The screw conveyor was turned inside the reservoir. Some powder was put in it and the conveyor was rotated. The working model was analysed. It was observed that when the screw was rotated, the powder fell from the compartment in an uneven manner. This model seemed appropriate for coffee machines; however, it wouldn't have served the purpose ofprecise powder selection. The fall of the powdered ingredients should have been even and at a specified rate. An uneven fall would further involve a complication wherein the amount of powder would need to be aptly sensed. This might thus require the use of highly sensitive load sensors. The use of such devices would only exhilarate the cost of such equipment.

The exact amount inputted was to be made available by the machine. A mechanism was to be developed that involved having the volume of powder being predetermined. The calibration was to be such that the number of rotations corresponded to a particular volume of powder.

Based on this concept a model was designed. The designing involved the use of software called CORAL. The design was

based on the principles of predetermination of the volume of powder falling through a particular slot. The design involved the use of slotted discs. The circular discs were to be arranged in a manner so as to provide and exact volume of powder. They were to be such that each rotation would yield that exact volume. A prototype was created using form sheet. Circular discs were made based on the dimensions of a standard mixer jar. The reservoir for the machine was chosen to be the standard mixer jar. The discs in form sheet were cut using a grinding machine to get exact circular shape. These circular slotted discs were arranged in a specific order and placed at the bottom of the mixer jar.

The selector disc- The disc represented in Fig 3.2 is the selector disc. The different holes along the circumference on the selector disc were made so that the slot size could be adjusted. A pin was to be fitted on the disc above the selector disc so that it suits the holes on the selector disc and according to the requirement the selection of slot could be made.

The bottom slotted disc in Fig. 3.3 was to remain fixed onto a platform and the final amount of powdered ingredient falling is through this disc. The amount of portion of slot open to powder fall depends on the selector disc opening. Only the required amount of powder is delivered through the slot.

The upper slotted disc in Fig. 3.4 makes the top cover of the slotted discs arrangement. Through this the powder falling is delivered downwards through a selective opening.

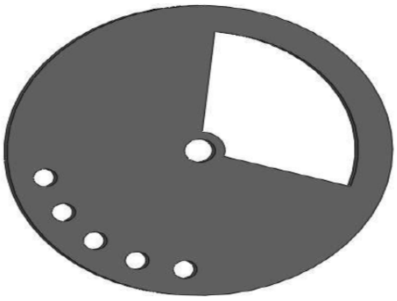

Fig. 3.2 The Selector Disc

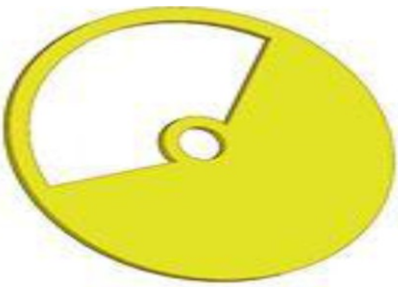

Fig. 3.4 The Upper Slotted Disc

3.2 STAGES OF THE PROTOTYPING:

1. Making of the bottom slotted discs

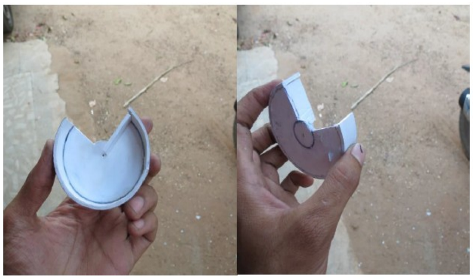

Fig. 3.5 Photographs depicting the making of the bottom slotted disc

The figure depicted above i.e in Fig. 3.5 above show the bottom slotted disc portion made of form sheet material. This part has the same dimension as that of the inner diameter of a standard mixer jar. Circular shapes were accurately obtained by shaping form sheet using a grinding machine.

2. Making of the top cover of the discs

Fig. 3.6 Photographs depicting the making of the top cover

3.Aligning of the two parts

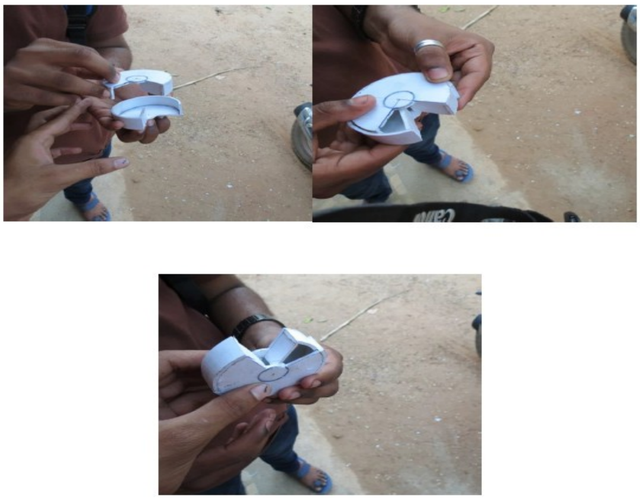

Fig. 3.7 Photographs depicting the allignment of the two prototype discs

The photographs in Fig. 3.7 depict the aligning of the two parts such that the top cover exactly fits into the bottom base and is able to freely rotate within the base.

4. Making of the base and choice of mixer jar

Fig. 3.8 Photographs depicting the placing of the prototype into the mixer jar

base suited to a standard mixer jar is made as depicted in Fig. 3.8. The dimensions matching that of the inner base of the jar. This is followed by placing the form sheet models made into the mixer jar. The base is put into it first, followed by the arrangement of bottom slotted disc and top cover. This is depicted in the Fig 3.9 below:

Fig. 3.9 Photographs depicting the complete arrangement of the prototype

The above figures depict the manner in which the prototype was arranged. This mechanism was then tested by mounting a shaft on it and rotating it. The rotation was found to be without hindrance and quite smooth. As part of the testing procedure, some amount of powder-namely, the plain white refined flour (Maida) was filled in the jar. The discs were then rotated again at a constant speed. There was no hindrance owing to the cohesiveness of the powder. The rotation of the discs was also uniform. The rate of fall of powder through the slots remained constant. Thus a mechanism was attained that could appropriately provide a uniform measure of powdered substance.

4. PRODUCT CHARACTERISTICS

4.1 ELECTRONIC ASPECTS

Embedded C is a set of language extensions for the C Programming language. This was chosen as the language for programming in this project. It was most suitable for the embedded systems programming. The language is simple and easy to use. It was also suited to the microcontroller chosen i.e. a 16F876A microchip.

4.1.1 Logic of program for operation of remote control

The program for the operation of the remote control was developed. A remote control was required to provide an input to the device. The input to the machine was provided as the number of rotations for each of the 3 sets of sweeping discs mounted within 3 separate mixer jars. The remote control was to have 3 control knobs for each of the 3 apparatuses. It was to consist of an LCD screen. The remote control could be made to run on a non-rechargeable 9V battery. The remote end was connected to the end of the motors. The remote could be operated only when a signal from the motor end could be received. Once the signal has been received, which is achieved by clicking a button switch on that end, an indication is given to the user by changing the colour of an LED. The remote thus is ready to operate. There are various switches on the remote control each having specific functions. Only by pressing a switch continuously is it possible to change the values of number of rotations of each motor. In order to make it simple for the user, the LCD display screen reveals the number of rotations required for each motor. Consequently, by turning the knobs corresponding to each motor, the number of rotation values may be varied, i.e. in this manner manually the number of rotations for each jar is provided. There is a send button on the remote control to send these values to the microcontroller at the motor end. There is also an option to send predetermined values of number of rotations. The automatic setting is for specific recipes and this number of values is set by the programmer. Four sets of 3 values for each is pre-set and stored, and each of them can be attained by clicking specific buttons on the remotecontrol and consequently sending them to the motor control end. Without clicking the send button the values would not be send to the motor control end and it cannot made to be run. The photograph of the remote control is shown in Fig. 4.1 with all its details.

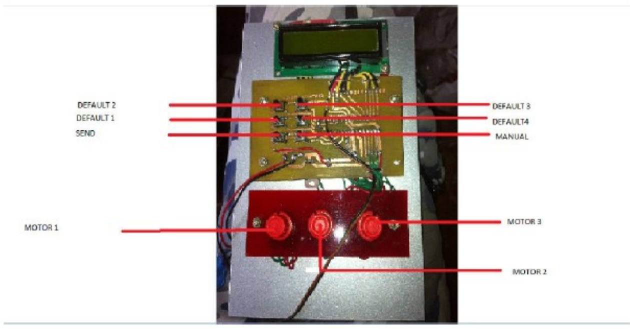

Fig. 4.1 Photograph of the remote control with functions of all switches.

4.1.2 Logic of program for running the motors

The motor control end had the microcontroller with another program file embedded within it. This was to have a control over the 3 motors operating in tandem. The initial supply voltage received enables the 3 motors and renders them to align themselves so that all 3 discs are at the same position before values are received by the three. Once the discs are aligned, the remote control end values are sent, this causes a change in the colour of the LED indicating the receiving of the values. In order to start the motor operation, however, the switch requires

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to be pressed triggering another change in colour on the LED and consequent operation of the device. According to the number of rotations received on each of the motors, the discs are rotated and powdered substance fall according to the slots present on the discs. The rotation values required for each amount of powdered substance was predetermined and calculated in advance and provided to the user to make the operations simpler.

5.ANALYSIS

The analysis of the product was performed in Solidworks software platform according to the dimensions of the product and the following results were obtained:

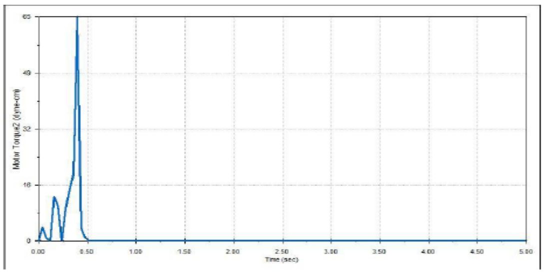

Fig. 6.1 Plot between motor torque and time

The above graph shown in Fig. 6.1 is a depiction of the motor torque variation with time. It is seen that during the initial period the motor undergoes sudden jerks and an increase of torque with a maximum of 65 dyne-cm =0.0000065 Nm.

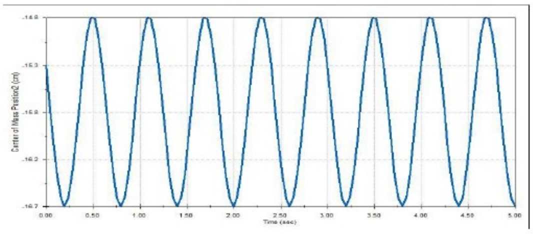

Fig. 6.2 Plot between centre of mass and time

The graph in Fig. 6.2 reveals variation of centre of mass of particles on the sweeping disc arrangement with time. It was observed to be varying continuously with time.

5.1 FORCE ANALYSIS

To check for the failures of the jar while it is completely loaded, the jar was filled upto the brim with sand whose density the software already has in its material database. The centre shaft and the top disc were kept fixed and rigid connections were established on them.

The bottom disc was rotated at 100rpm and found the stress concentrations on various elements in the mesh of the bottom disc. From Fig. 6.3, the maximum stress developed in the analysis was 2.574 N/mm2.

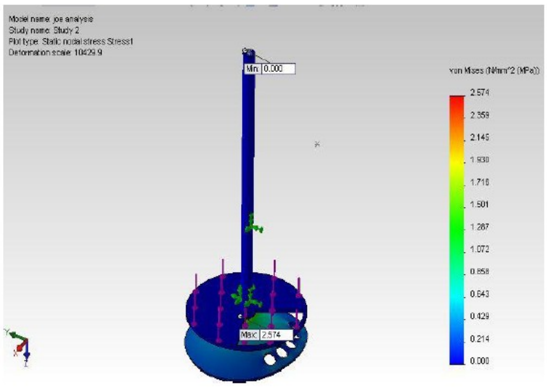

Fig. 6.3 Analysis of Static Nodal Stresses on the Sweeping Disc Mechanism

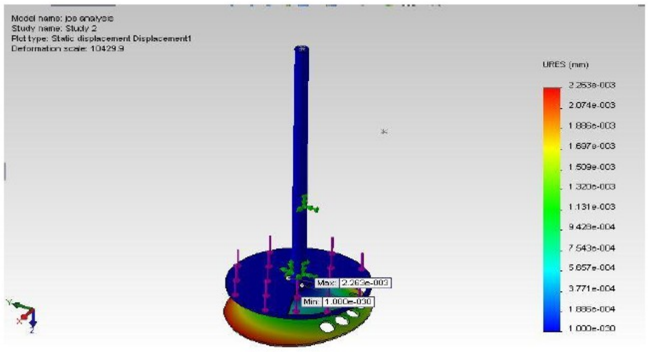

Fig. 6.4 Displacement Analysis on the Sweeping Disc Mechanism

The above image in Fig. 6.4 shows displacement of the various components subjected to a maximum loading condition. The discs here were to withstand sand in a completely loaded condition and were made to rotate at a speed of 100 rpm. The purple downward arrows here represent the distribution of forces acting on the component. The green arrows represent the constraints that the component is subjected to. Here it is observed that the maximum amount of displacement was at the rotating component. The static components were hardly found to have any form of displacement. Even the highest order of displacement here was found to be 2.263e-003mm.

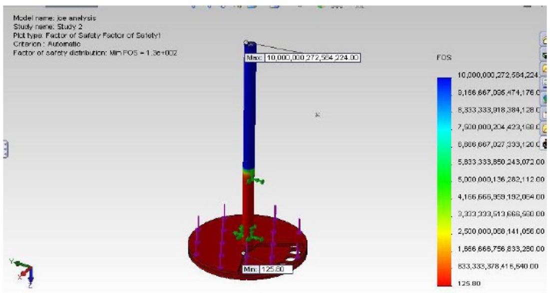

Fig.6.5 Factor of Safety Analysis on the Sweeping Disc Mechanism

Further analysis was made on the factor of safety distribution required for the rotating mechanism. It was found from Fig. 6.5 to have a minimum Factor Of Safety of 1.3e+002.

Similar analysis was made on screw conveyor mechanism. The stress analysis revealed that a maximum stress of

1220294000 N/m2 was received on the screw conveyor running at the same torque.

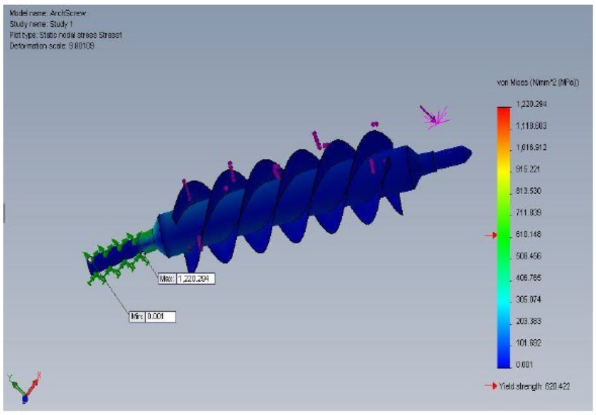

Fig. 6.6 Static Nodal Stress Analysis on the Screw Conveyor Mechanism

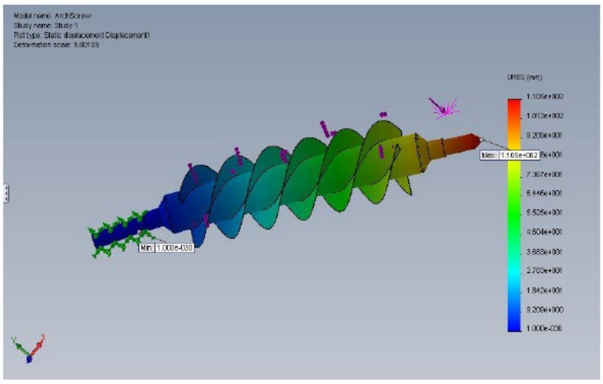

Fig. 6.7 Displacement Analysis on the Screw Conveyor Mechanism

Displacement analysis also revealed area of varying displacement throughout the screw conveyor beam. It had a maximum displacment of 1.105e+002 mm. Thus it was observed that the screw conveyor mechanism had greater variations of displacement along the beam and it is also aided by the fact that it is a cantelever load. Therefore chances of failure are greater and the sweeping disc mechanism is more suited to serve the purpose of exact powder delivery.

5.2 FREQUENCY ANALYSIS

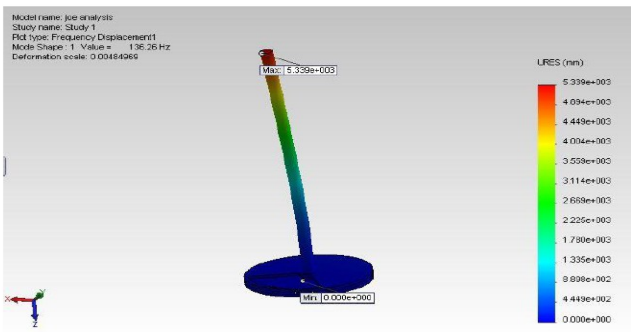

Fig. 6.8 Frequency Displacement on the Sweeping Disc Mechanism (Mode 1)

The image shown in Fig. 6.8 depicts the first mode frequency displacement on the sweeping disc mechanism. The next two modes are shown in figures, Fig. 6.9 and Fig. 6.10 respectively.

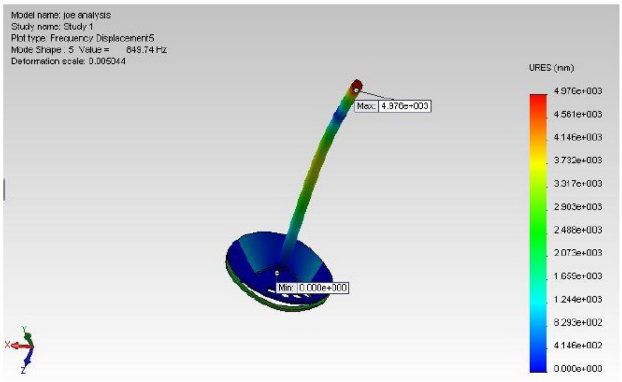

Fig. 6.9 Frequency Displacement Analysis (Mode 2)

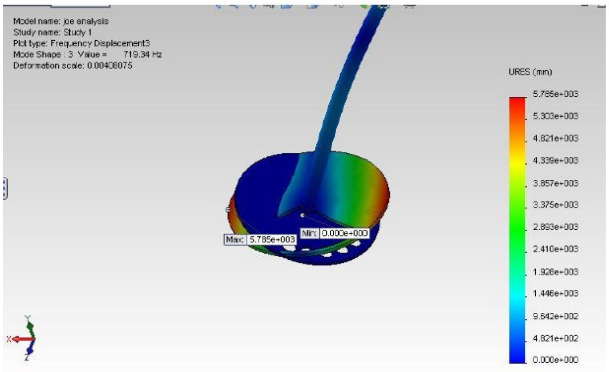

Fig. 6.10 Frequency Displacement Analysis (Mode 3)

The three figures Fig. 6.8, Fig. 6.9, Fig 6.10 above show the deformation of the discs and the shaft at its natural frequencies; the least observed among the mode shapes was at 136 Hz, this tells us that the system would fail if operated above 136 Hz.

The rpm of the system= 100 rpm

Angular velocity of the system = = 10.47 rad/sec

Now frequency=2*π*Angular velocity

Angular velocity= 10.47 rad/sec

Frequency= 65.80 Hz

As the operating frequency is less than the first mode shape frequency, the design is safe.

6. CONCLUSION AND SCOPE FOR FUTURE WORK

The sweeping disc mechanism was made an apparatus that delivers granular matter at exact amounts. The requirement was to have a user friendly device which could be operated for recipes at all levels. The sweeping disc mechanism was ideally suited for the requirement. The exact amount of powdered substance was to be obtained and this was achieved.

The entire device was operated on a 6V battery and the required torque for rotating the discs as well as making the granular matter fall smoothly was obtained. Different varieties

of powders, each having different densities were made to fall. According to the variation in density the mass flow rate of powders varied and this was observed and promptly noted.
The model could be modified as follows:

1. A number of reservoirs/jars could be added to the set up and this would allow the machine to be made applicable to a larger purpose.
2. With this the number of ingredients for a recipe could be predetermined and we could get proper cooked food.
3. Provision for mixing of ingredients could also be included.
4. Provision for cooking can also be incorporated by providing a setup for boiling and that for containing water.

REFERENCES

[1]. Philip J. Owen and Paul W. Cleary, (2009) Screw Conveyor Performance: Comparison of Discrete Element Modelling With Laboratory Experiments. Seventh International Conference on CFD in the Minerals and Process Industries CSIRO, Melbourne, Australia 9-11 December 2009.

[2]. J¨urgen Tomas, (2004) Fundamentals of cohesive powder consolidation and flow. Granular Matter 6, Pages: 75–86.

[3]. Jigar N. Patel, Sumant P. Patel, Snehal S. Patel, (2013) Productivity Improvement of Screw Conveyor by Modified Design. International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 1, January 2013, Pages: 492-496.

[4].Jeetender Singh Chauhan, Sunil Semwal, (2013) Microcontroller Based Speed Control of DC Geared Motor Through RS-232 Interface With PC. International Journal of Engineering Research and Applications (IJERA), Pages: 778-783.

[5]. Alexander Chatzigeorgiou and George Stephanides, (2002) Evaluating Performance and Power of Object-Oriented Vs. Procedural Programming in Embedded Processor, Department of Applied Informatics,University of Macedonia, Pages:65-75.

[6].Sérgio Paulo Hilgenberga, Emigdio Enrique Orellana-Jimeneza(2008) Evaluation of Surface Physical Properties of Acrylic Resins for Provisional Prosthesis, Materials Research, Vol. 11, No. 3, Pages:257-260.